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SPECIAL ADVANCED STUDIES FOR POLLUTION PREVENTION
Delivery Order 0058: "The Monitor" – Spring 2000

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MATERIALS AND MANUFACTURING DIRECTORATE
AIR FORCE RESEARCH LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433-7750

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THIS TECHNICAL REPORT IS APPROVED FOR PUBLICATION.

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KENNEDY SPACE CENTER (KSC) HOSTS THE 14TH AIR FORCE MATERIEL COMMAND (AFMC) CENTER WORKING GROUP (CWG) MEETING.. ***see Page 3***

In this issue...

The MONITOR is a quarterly publication of the Headquarters Air Force Materiel Command (AFMC) Pollution Prevention Integrated Product Team (P2IPT) dedicated to integrating environment, safety, and health related issues across the entire life cycle of Air Force Weapon Systems. AFMC does not endorse the products featured in this magazine. The views and opinions expressed in this publication are not necessarily those of AFMC. All inquiries or submissions to the MONITOR may be addressed to the Program Manager, Mr. Cliff Turner.

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THE MONITOR ON INTERNET

This issue of the MONITOR is available on the Internet at the ASC site (http://www.ascenv.wpafb.af.mil/monitor.htm). The current issue of the MONITOR is in a Portable Document Format (PDF) file which requires a reader program for viewing or downloading. The Adobe Acrobat reader is available for downloading at no cost.

KENNEDY SPACE CENTER (KSC) HOSTS THE 14TH AIR FORCE MATERIEL COMMAND (AFMC) CENTER WORKING GROUP (CWG) MEETING

The 14th Air Force Materiel Command (AFMC) Center Working Group Meeting (CWG) was held at the Kennedy Space Center (KSC) from 8-10 February 2000. Maj. Gen. (R) Bridges, KSC Center Director, welcomed participants to KSC and commended the group's efforts to address "global partnering opportunities into the millennium." Ms. Debbie Meredith, AFMC CWG Chair, outlined the objectives of this meeting that included "understanding the importance of partnering, facilitating future partnership, and identifying common needs." She encouraged the participants to share business practices and cross-feed lessons learned.

Mr. Gary Vest, Principal Assistant, Undersecretary of Defense, Environmental Security, and Mr. Tad McCall, Secretary of the Air Force, Manpower, Installation, and Quality (SAF/MIQ) provided the Department of Defense's (DoD's) and the Air Force's views, respectively, on global partnering opportunities.

In the research and development (R&D) and technology transition arena, Dr. Jeff Marqusee summarized the Strategic Environmental Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP). Mr. Tom Naguy discussed Air Force Research Laboratory's (AFRL's) Pollution Prevention (P2) projects and ongoing SERDP P2 initiatives. Mr. Mike Spicer, Coating Technology Integration Office (CTIO) presented the ESTCP funded Applique Coatings project and the Air Force's Advance Performance Coatings (APC) project. Mr. Roger Johnson discussed Electrospark Deposition technology, an opportunity for partnership with Pacific Northwest Laboratories.

The following participants discussed partnership opportunities within the DoD, National Aeronautics Space Administration (NASA), and other supporting organizations:

- Ms. Olga Dominguez and Mr. Bob Hill provided an overview of the NASA Environmental Program and the Acquisition Pollution Prevention Program.
- Ms. Debbie Meredith and Mr. Bob Hill provided an update on the Joint Group on Pollution Prevention (JG-PP).
- Mr. Dave Asiello summarized on going Navy Pollution Prevention efforts.
- Mr. Jeff Conrad provided an overview of the Army's Pollution Prevention Program.
- Mr. Mike Katz provided information on the National Defense Center for Environmental Excellence (NDCEE) and the Materials & Process Partnership for Pollution Prevention (MP4) Program.
- Dr. Paul Chalmer discussed partnership opportunities available through the National Center for Manufacturing Science (NCMS).

Voting members (see Figure 1) of the AFMC CWG provided an update of their organization's activities. In addition to presentations, the participants toured the Saturn Five Facility and witnessed the launch of the Endeavor Space Shuttle on 11 February 2000. This issue of the MONITOR summarizes some of the briefings presented at the 14th AFMC CWG. For a copy of the briefings presented at the CWG, please visit the CWG website at http://www.afmc-mil.wpafb.af.mil/cwg.

The next AFMC CWG is scheduled from the 25-27 July 2000 at Hill AFB, Ogden. This meeting will focus on weapon system compliance through pollution prevention (CTP2) issues. For additional information regarding AFMC CWG activities, please contact Ms. Debbie Meredith at DSN 787-7505 or Ms. Lori Luburgh at DSN 787-7352.◆

Organization	Name
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➨ ASC	➨ Lt Col Steve Clift
➨ OO-ALC	➨ Mr. Craig Shaw
➨ WR-ALC	➨ Mr. Dave Bury
➨ OC-ALC	➨ Mr. Carlos Nazario
➨ AFFTC	➨ Ms. Mary Spencer
➨ AAC	➨ Mr. Jim Fitzpatrick
➨ ESC	➨ Mr. Peter Logan
➨ HQ AETC/LG-EM	➨ CMSgt James Long
➨ SMC	➨ Major(S) Henry Cabrera
➨ HQ ACC/LG-EM	➨ Mr. Bruce Stephens

Figure 1. CWG Presentations by Voting Members

THE STRATEGIC ENVIRONMENTAL RESEARCH AND DEVELOPMENT PROGRAM (SERDP) & ENVIRONMENTAL SECURITY TECHNOLOGY CERTIFICATION PROGRAM (ESTCP) PARTNERING OPPORTUNITIES

The Strategic Environmental Research and Development Program (SERDP) is the Department of Defense's (DoD) corporate environmental research and development (R&D) program. The SERDP responds to highest priority DoD user needs and congruent Department of Energy (DOE) needs. SERDP accelerates technology development through proof-of-principle, and promotes partnering by leveraging resources and reducing duplication of effort. The SERDP program sponsors annual solicitations to meet DoD needs — two solicitations open to all government, academia, and industry, with competitive awards and an external peer review and a Scientific Advisory Board review. SERDP encourages end-user participation and structures projects to lead up to a technology transition or demonstration/ validation effort.

The goal of the Environmental Security Technology Certification Program (ESTCP) is to demonstrate/validate innovative, cost-effective environmental technologies and to promote DOD implementation. This is done by leveraging past investments to transition technology into the field. The ESTCP approach is to partner with stakeholders and to perform the evaluations at DOD facilities to facilitate the resolution of operational cost and performance issues.

There are opportunities for your participation in both programs. You can become involved through the annual SERDP and ESTCP proposal solicitations or by participation in the annual, SERDP/ESTCP symposium in Washington DC. The next Symposium will be held November 28-30, 2000 at the Hyatt Regency in Crystal City, VA.

For more information see the ESTCP homepage at http://www.estcp.org and the SERDP homepage at http://www.serdp.org.

Source: 14th AFMC Center Working Group Meeting, Kennedy Space Center◆

AFRL/MLQL EVALUATES NON LINE OF SIGHT (NLOS) ALTERNATIVES FOR CHROME PLATING

Hard chromium electroplating operations are used at Air Force Air Logistic Centers (ALCs) to repair worn components. Electrodeposited hard chromium possesses high hardness, a low coefficient of friction, good abrasion and wear resistance, resistance to seizure, and good machinability. However, hard chromium electroplating uses hexavalent chromium, a carcinogen that is detrimental to worker health and safety and the environment. Therefore, the use and disposal of hexavalent chromium is strictly controlled by federal and state regulatory agencies. Complying with these regulations has increased disposal costs as well as liability and risk for the Air Force. Finding an alternative to hexavalent chromium electroplating is a high priority within the Air Force ALCs.

The Air Force and other Department of Defense (DoD) organizations have been investigating high-velocity oxy-fuel (HVOF) thermal spray coatings as a replacement for chromium electroplating. However, HVOF thermal spray is a line-of-sight (LOS) technology. It is estimated that HVOF thermal spray can accommodate 60-80% of the component presently hard chromium plated; however, non-line-of-sight (NLOS) technologies are required for the remaining 20-40%. This portion consists of components that possess internal diameters, blind holes, and other complex features.

Project Description

Air Force Research Laboratory Materials Directorate, Weapon System Logistics Branch (AFRL/MLQL) is implementing a four phase project (see Figure 2 on Page 5) to identify and evaluate environmentally acceptable alternatives to hexavalent chromium electroplating for NLOS applications. This project is funded by Headquarters Air Force Materiel Command, Pollution Prevention Division (HQ AFMC/CEVV), as approved by the HQ AFMC Pollution Prevention Integrated Product Team (P2 IPT). The objective of this project is to identify, demonstrate, validate, and implement chemical/electrochemical process alternatives to hard chromium plating processes for NLOS applications at Air Force ALCs that can be "dropped in" to existing operations.

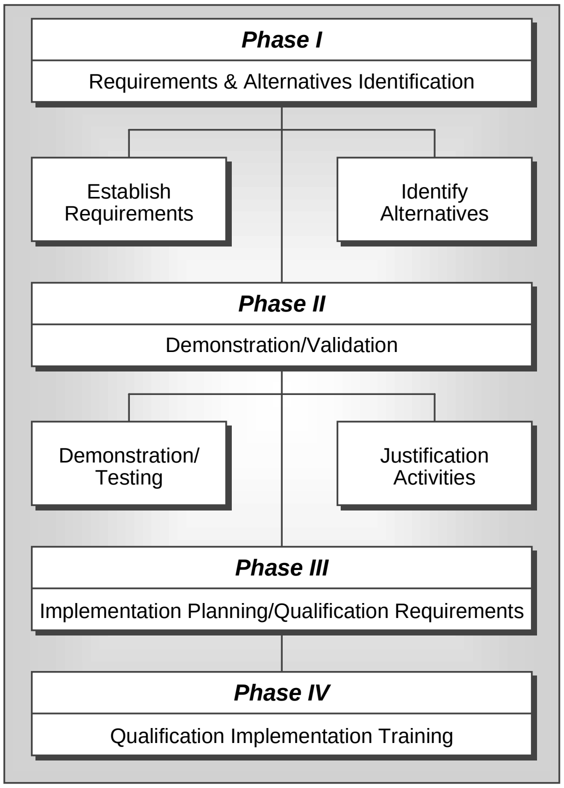

Figure 2. Overview of NLOS Chrome Plating Project

Phase I of the project, which has recently been completed, analyzed and established ALC requirements and identified and down selected viable alternatives. Phase II of the project will demonstrate, optimize, and justify the selected alternatives and further validate ALC requirements. Phase III of the project will involve preparing implementation plans and developing qualification requirements. Phase IV will focus on alternative (s) implementation at the ALCs, including the necessary training and follow-up.

Phase I Project Results

Figure 3 summarizes key findings from Phase I. During this phase, site surveys were conducted at Oklahoma City Air Logistics Center (OC-ALC), Ogden Air Logistics Center (OO-ALC), and Warner Robins Air Logistics Center (WR-ALC) to identify NLOS candidate parts, the coating requirements for these parts, and any processing method considerations. Survey findings indicated that NLOS chrome plated parts comprise 26-39% of the workload at OC-ALC and 22-66% of the workload at WR-ALC. The correlating workload for OO-ALC could not be determined. The coating requirements and process considerations for these parts, identified during the ALC site visits, have been summarized in Figure 3.

Chromium Plating Non-Line of Sight Alternatives

Air Logistic Centers Requirements

Coatings Requirements

- Meet Federal Specification, Chromium (Electrodeposited) (QQ-C-320B) performance requirements
- Display anti-galling characteristics
- Easily removed
- Possess a hard, wear resistant surface
- Obtain a 32rms finish on ODs and axle journals
- Obtain a 5-6rms finish on seal journals
- Coat parts typically 6” diameter x 3’ long
- Attain coating thickness typically between 8-15 mils

Process Considerations

- Generates less waste and is a less toxic process
- Is economically feasible (in terms of required facilities, equipment, raw materials, and power consumption)
- Produces deposits of consistent quality - reproducible
- Displays comparable quality control requirements
- Adaptable to existing plating shops
- Display similar processing times
- Eliminate hydrogen embrittlement concerns
- Enables the use of an easily applied maskant

Data Collection Requirements for Alternatives

- NLOS applicability
- Hardness
- Corrosion resistance
- Thickness limitations
- Environmental concerns
- ESOH considerations
- Fatigue
- Temperature Resistance
- Maximum process temperature
- Adhesion to steel
- Wear resistance
- Capital cost
- Cost per mil/ft^2
- Deposition rate
- Post-plate grinding considerations
- Process complexity
- Strippability
- Maturity
- Process type and chemistry
- Licensing requirements
- Vendor information

Phase 1 - Alternative Findings Candidates

- Niplate 700 (Surface Technology) - Electroless nickel (EN) process that contains silicon carbide (SiC) particles
- Niplate 800 (Surface Technology) - Composite diamond coating (CDC) that combines a hard nickel matrix (6-9 weight - % phosphorous
- Niklad 797 (MacDermid) - Electroless Nickel Phosphorous (ENP) process that produces a coating containing 3-5%, by weight, phosphorous
- Enfinity HX (Stapleton Technology) - Functional EN coating, containing 0-3% phosphorous
- Millenium KR (Sirius Technology) - EN composite system that contains 6-8% boron nitride particles (by weight) and 4-6% phosphorous (by weight) in a nickel matrix
- EnLoy 500 (Enthone) - Nickel-tungsten (65% by weight Ni, 35% by weight W) is electrolytically deposited

Figure 3. Chromium Plating Non-Line of Sight Alternatives Results

During Phase I, alternative processes with the potential to replace hard chromium plating at the ALCs were identified through literature searches and by contacting vendors supplying plating chemicals. Figure 3 also summarizes the type of data collected for each identified alternative, where such data was available. The collected information was complied in a 3-tier Microsoft Excel database and divided into three categories (i.e., available technology, engineering development phase, and R&D phase). A "go/no go" decision was made on the alternatives based on: 1) NLOS coverage; 2) chemistry; 3) adhesion properties: 4) thickness requirements; and 5) maturity. Alternative selection focused only on commercially available technologies. The most readily available alternatives, from the 34 down selected processes, were nickel based, although some proprietary processes are being developed.

Based on input from the key stakeholders, a ranking criterion was established for each data parameter to further down-select alternatives. Through decision tool results and scenario-based evaluations six candidates were identified. These six candidates, summarized in Figure 3, include the following:

- Niplate 700 (Surface Technology Product)
- Niplate 800 (Surface Technology Product)
- Niklad 797 (MacDermid Product)
- Enfinity HX (Stapleton Technology Product)
- Millennium KR (Sirius Technology Product) and
- Enloy 500 (Enthone Product).

Phase II of this project will gather any missing information on these alternatives and further validate these alternatives through testing on steel substrates.

For additional information regarding this project, please contact Mr. Tom Naguy, AFRL/MLQL at DSN 986-5709.

Source: 14th AFMC Center Working Group Meeting & Dave Schario (CTC) ◆

ENVIRONMENTAL SECURITY TECHNOLOGY CERTIFICATION PROGRAM (ESTCP) SPONSORS AN APPLIQUE COATINGS DEMONSTRATION AND VALIDATION PROJECT

The Environmental Security Technology Certification Program (ESTCP) has sponsored a joint effort between the United States Navy and the United States Air Force to validate applique technology in depot and field environments as a topcoat replacement. Mr. Dave Rizolo serves as the Navy Lead and Mr. Mike Spicer serves as the Air Force Lead for this project. The ESTCP project will identify and address application, maintenance, repair, non-destructive inspection (NDI), and removal related issues to ensure the successful transition of the applique system to the depot and the field units.

Historically, Original Equipment Manufacturers (OEMs) and 3M have implemented applique projects as single prototypes to demonstrate technology feasibility, satisfy flight safety concerns, and conduct laboratory product demonstration on different films and adhesives. The initiatives to date have successfully identified three viable adhesives (i.e., 52-1, 52-2, and 52-4) and two applique films (FP 500 and FP1500). However, compared to paint, applique technology involves new materials, tools, and processes, and therefore must address a variety of issues prior to successful implementation fleet wide. The ESTCP project is the first effort to address the applicability, maintainability, repairability, and removability of applique coatings on fully covered aircraft. As such, the project aims to determine the cost effectiveness of the applique technology.

The data gathered from this project will be used to create cost comparison models for the respective weapon systems (i.e., S-3, C-130 and F/A-18 aircraft). These models will compare the costs of using paint versus applique for a full programmed depot maintenance (PDM) cycle. The respective Single Managers can use the cost models to determine the return on investment (ROI) and total ownership cost (TOC). Additionally, the cost models will be used to determine additional work needed to further improve the applique technology.

Project Description

The focus of the ESTCP project is to conduct multiple aircraft demonstrations using depot and field personnel in the application, maintenance, and repair of the applique technology. Conducting multiple technology demonstrations, identifying logistical and operational requirements/constraints, determining the cost effectiveness of the process, and transitioning laboratory testing to full product demonstration will facilitate fleet wide implementation of the technology.

During the course of this project, field unit personnel will obtain the required experience to maintain and repair applique by assisting depot personnel with the application process. The applique will remain on the test aircraft (s) for the full PDM cycle. The application, repair, and removal of applique will take place at Navy and Air Force installation on the S-3, C-130, and F/A-18 aircraft. These aircraft were selected because their operating environments are land and carrier-based with mission profiles that are supersonic with a short flight duration, and subsonic with a long flight duration.

Data inputs required by the cost comparison model will also be gathered during the depot and field level activities. Some of the 65 data input elements to the cost model include: depot man-hours per process step; O-level man-hours; support equipment procurement and maintenance; training development and yearly cost; technical data development and update; corrosion damage; disposal costs; and fuel consumption.

Results & On-going Efforts

The S-3 was the first aircraft covered with applique under this effort. Depot personnel applied applique to near 100% of the outer moldline of the S-3 at North Island Depot. After the first local flight check, major applique failures were detected. Teams from Lockheed, 3-M, and the Navy evaluated the situation and determined the failures were the result of many contributing factors, which are summarized below under "Lessons Learned."

Based on the team evaluation, it was decided to remove the applique, scuff sand the primer in order to achieve a smoother surface, and re-apply the applique. The S-3 experienced no failures on the next local flight check and was sent back to its operational unit at Jacksonville, FL. The result of the cross-country flight is summarized under Lesson Learned #4. Although the S-3 experienced minor problems upon arrival at Jacksonville FL, the applique was removed due to the flight clearance being revoked. Complications with authorized adhesives was the reason for cancellation of the flight clearance. The S-3 community is performing additional coupon testing prior to a second full coverage. The test work document is being written for the coupon test on the second S-3 aircraft. The coupon flight test began December 99 and will consist of five flights.

Taking the lessons learned from the first S-3 effort, primarily importance of the interface of the applique adhesive and the primer (see Lessons Learned #1), two types of applique films with three types of adhesives over C-130 primers are being tested in the laboratory before application to a C-130 aircraft. The objective of this testing is to evaluate primer cure time versus surface roughness versus primer type. This testing will occur with perforated and non-perforated applique. Additionally, panels will be created to test applique over the topcoat/primer interface. Laboratory testing will be completed by July 2000 and a complete coverage of an Air Force C-130 aircraft is expected to be completed by December 2000.

Lessons Learned From The First S-3 Aircraft

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The lessons learned from the first full coverage of the S-3 aircraft are as follows:

1. **Applique Behaves as a System –** The performance of the applique system is dependent on the interaction of all the components that make up the system. Altering any component may change the overall performance of the applique system. Specifically, the results from the first S-3 aircraft demonstrate the importance of the interface between the primer and applique adhesive. This interface is dependent on both the primer and the applique adhesive used. In the case of the first S-3 aircraft, the adhesive used was 52-2, which is a stiffer adhesive and thus less forgiving to rougher surfaces. The reformulation of the adhesive was in part responsible to the observed failures discussed under lessons learned # 2 and 3.

2. **Proper Aircraft Surface Preparation is Critical to the Success of the Applique System** – Surface preparation observations during the S-3 aircraft demonstration included that adhesive strength: 1) increases with primer cure time; and 2) increases with decreasing surface roughness. During the first S-3 aircraft demonstration, applique failure occurred at 100-micron inch surface roughness. The ideal surface roughness of the primer for applique bonding was determined to be 60-micron inch or less. The possible causes of the primer surface roughness may

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US ARMY ACQUISITION POLLUTION PREVENTION PROGRAM UPDATE & PARTNERING OPPORTUNITIES

The Army Acquisition Pollution Prevention Support Office executes the Army Acquisition Pollution Prevention Program by supporting Installation Commanders, Program Executive Officers/Program Managers (PEOs/PMs), developing policy and guidance, and by managing facility and weapon system projects. The program is organized into six commodity Integrated Product Teams (IPTs): communications and electronics; tank, automotive and armaments; aviation and missile; chemical, biological and soldier support; ordnance; and research. The mission, for their respective commodities, is the identification and prioritization of pollution prevention (P2) requirements; obtaining and allocating resources; planning P2 projects; managing project execution; and supporting PEOs/PMs. The most important function is integration with all involved organizations and other programs.

The process by which the Army Acquisition Pollution Prevention Program operates is summarized in Figure 4.

1 ➔ Identify HAZMAT Requirements
2 ➔ Evaluate Impacts on the Army
3 ➔ Evaluate Courses of Action
4 ➔ Identify & Evaluate Potential Alternatives
5 ➔ Select Best Alternative & Develop Project
6 ➔ Prioritize Projects by Commodity
7 ➔ Rank Order Projects at Army Level
8 ➔ Resource Projects
9 ➔ Execute
10 ➔ Verify Cost and Savings

Figure 4. Army Acquisition P2 Program Process

All product submissions address Army Mission Needs as defined by the Environmental Technology Technical Council (ETTC) and meet the Assistant Chief of Staff for Installation Management (ACSIM) environmental program pollution prevention requirements. Figure 5 summarizes Army's P2 mission needs and Figure 6 (see page 9) shows the status of the Army Acquisition P2 Program.

	Top Army P2 Mission Needs
1	Non-hazardous solid waste reduction
2	Develop an improved chemical agent resistant (CARC) system
3	Alternatives to ozone-depleting fire fighting agents
4	Reduce/eliminate pollution from ordnance manufacture, maintenance, use and surveillance
5	Reduce/eliminate pollution from surface protection processes
6	Pollution prevention in facility construction, operation, repair and demolition
7	Reduce/eliminate pollution from military unique power sources
8	Alternatives to open burning/open detonation
9	Reduce eliminate pollution in priming, sealing and adhesive processes
10	Improved nuclear, biological and chemical (NBC) decontamination techniques including weapon systems and equipment
11	Reduce/eliminate pollution in composite manufacturing and repair
12	Alternative cleaning technology for non-CARC painting equipment
13	Reduce/eliminate pollution from the manufacturing and testing of military clothing and textiles
14	Depainting non-CARC Army coatings
15	Review, evaluate, develop and gather data for environmental lifecycle models
16	Develop environmentally compatible lubricants and fluids
17	Alternative to ozone-depleting refrigerants

Figure 5. Army P2 Mission Needs

Twenty-five projects are funded for FY00, nine are new starts and sixteen are continuation projects. The average project duration is 3.6 years. FY00 costs are $3.7M with a total cost after implementation of $19.7M. Savings after implementation are $884.4M with the average payback period being 1.9 years. The cost is $1 for $45 of benefit. The FY00 Projects are summarized in Table 1 on page 10.

Where We Are Now		
Category	**Originally**	**Now**
Top 10 TRI Chemicals	1,902,686 lbs	515,735 lbs - Sown by 73%
Halon in Weapons	21,000 Veh 430,000 lbs	Found subs for all but 1 app; Coordinating revised Army plan now
Halon in Facilities	2,000 Systems 760,000 lbs	575 Systems - down 72% 400,000 lbs - down 48%
CFCs in Weapons	6,000 Veh 25,000 lbs	Retrofits in process
CFCs in Facilities	1,000 Systems 1,000,000 lbs	250 Systems - down 75% 220,000 lbs - down 78%
Hazardous Specs/Stds	2,949	1216 - down 59%
TDPs	9,000	Still working - long way to go
TMs, LOs, TBs, DMWRs	16,000	Still working - long way to go

Figure 6. Status of the Army Acquisition P2 Program

The Army Acquisition Pollution Prevention Program is participating in 11 active Joint Group on Pollution Prevention (JG-PP) projects that include the following:

- Low-VOC coatings for medium caliber ammunition (Lead Service)
- Alternatives to hydrazine in liquid gas generators (Lead Service)
- Alternative to monomethylhydrazine (MMH) in liquid/gel propulsion systems (Lead Service)
- Alternatives to electrodeposited cadmium for corrosion protection and threaded part lubricity applications
- Alternatives to lead-containing dry film lubricants for antigalling/anitfretting, antiseizing, and assembly aid applications
- Alternatives to high-VOC conformal coatings and lead containing surface finishes
- Low/no VOC and nonchromate coating system for support equipment
- Alternatives to solvent based ink stenciling for identification marking
- Portable laser coating removal system
- Nonchromate aluminum pretreatments
- Joint services cadmium alternatives team

The Army is very receptive to partnering, and even more receptive when the project addresses one of the top 17 Army P2 Mission Needs. For more information, please visit the following websites: www.aappso.com, www.jgpp.com, or contact Mr. Jeffrey R. Conrad, Corrpro Companies, Inc., 703-617-2816, jconrad@hqamc.army.mil.◆

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include overspray, low humidity, high air pressure, or high airflow during application.

3. **Pressurized Aircraft Present Additional Challenges for Applique -** Pressurization observations concluded that the inability to vent pressure leaks resulted in initiation of applique material failure. Pressurized air escaping through a leaking fastener or seam caused a bubble to form under the applique material. To resolve this failure, perforated applique was applied over pressurized areas when the S-3 aircraft was stripped of the applique, scuff-sanded to obtain a smooth surface and reapplied. No failures were observed around the pressurized areas or due to surface preparation problems. 3-M does not support the application of non-perforated applique on pressurize fuselages.

4. **Applique Material has a Temperature Limit -** Applique cannot withstand excessive heat, the temperature limit for applique is approximately 210 degrees F. During the cross-country flight from North Island depot to Jacksonville, FL, the S-3 experienced bubbling on the surface of the applique behind engines and the APU exhaust. Additionally, coupon failure behind the engine exhaust nozzle on AV-8B aircraft has been noted.

For additional information regarding this ESTP project, please contact Mr. Mike Spicer at DSN 785-0942.

Source: 14th AFMC Center Working Group Meeting, Kennedy Space Center.◆

Table 1. Army Acquisition P2 Projects (FY00)

FY00 Projects
AMCOM Projects: (IPT Mr. Ron Hagler, 256-955-0348)
➨ Evaluation of bondable stainless surface (BOSS) coatings for solid rocket motor casings
➨ Alternatives to hydrazine in liquid gas generators
➨ Alternatives to monomethylhydrazine (MMH) in liquid/gel propulsion systems
➨ Evaluation of alternate cleaners for cleaning prior to adhesive bonding
➨ Evaluation of alternate cleaners for non-metallic cleaning applications
ARL Projects: (IPT Mr. John Plumer, 410-306-0641)
➨ Reduction of HAP solvents in MIL-C-53072, MIL-C-46168 and MIL-C-53039
➨ Hazardous waste elimination or reduction in TT-C-490
➨ Environmentally acceptable wash primer DoD-P-15328
➨ Elimination/reduction of HAP solvents in MIL-P-53022 and MIL-P-53030
➨ HAPs free ammunition coating, MIL-E-11195 and primer, MIL-P-11414
CECOM Projects: (IPT Mr. John Myer, 732-532-5392)
➨ Non-flammable electrolyte for lithium-ion batteries
➨ Smart cable forward field charger for the individual soldier
➨ Carbon dioxide environmental control unit
IOC Projects: (IPT Mr. Jon James, 309-782-4175)
➨ Alternate non-toxic printing/labeling system for small caliber ammunition containers
➨ Alternate primer pocket sealant for 5.56 mm, M855 Cartridge
➨ Non-hazardous materials in primer mix NOL-130
➨ Replacement of Di-n-Butyl Phthalate as a deterrent in military ball propellants
➨ Environmentally safe M-21 flash composition
➨ Environmentally safe M-25 flash composition
SBCCOM Projects: (IPT Ms. Maryalice Miller, 410-436-3564)
➨ Upgrade from organic solvent binder systems to dry, aqueous or UV binder systems
➨ Instrumental method for agent desorption of CARC panels
➨ Two man chamber to test the integrity of new chemical protective ensembles
TACOM Projects: (IPT Mr. Tom Landy, 810-574-8818)
➨ Ultra-high pressure waterjet (UHPWJ) stripping of tracked and wheeled vehicles
➨ Barium alternative in small caliber ammunition trace and incendiary mixes
➨ VOC reduction and hazardous material elimination from repair procedures prior to repainting

AIR FORCE MATERIEL COMMAND (AFMC) VALIDATES THE COMPLIANCE THROUGH POLLUTION PREVENTION (CTP2) METHODOLOGY AT ROBINS AIR FORCE BASE

Air Force Materiel Command, Pollution Prevention Branch (AFMC/CEVV) is conducting a field test at Robins AFB from April – May 2000 to validate the functionality of the compliance through pollution prevention (CTP2) methodology.

Background

The CTP2 process, as shown in Figure 7, takes advantage of new technologies and accommodates mission changes to achieve continuous improvement in mission performance, reduction in total operating costs, and reduction in compliance requirements. This process is cyclical, and has the "plan – do – check – review" components of an Environmental Management System (EMS).

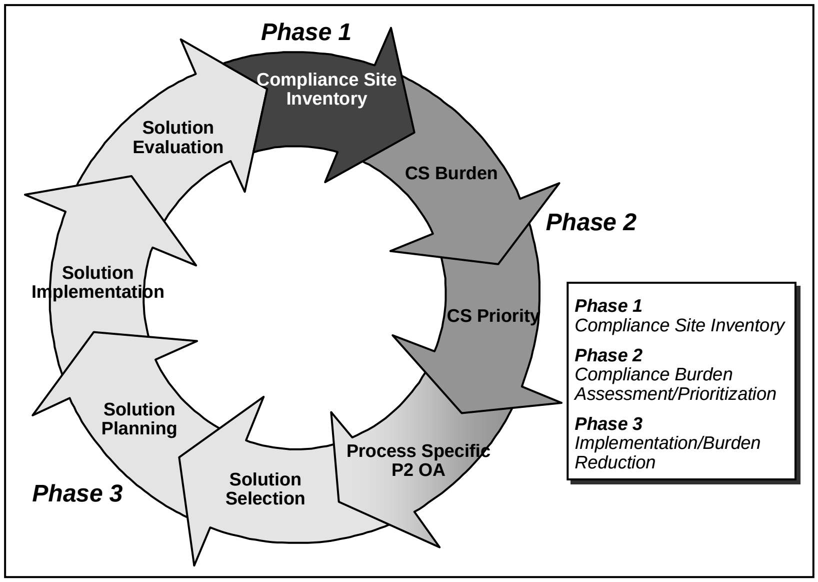

Figure 7. CTP2 Process

The CTP2 process is based upon the compliance site, which is any regulated facility, process, or discharge to a regulated facility or process. AFMC inventoried its compliance sites, then collected cost and risk data using cost distribution spreadsheets and a risk algorithm. The installations will now group the sites by process, activity, etc., before prioritizing them using criteria such as compliance burden, mission criticality, visibility, and other local considerations. The resulting inventories, maintained by the respective installations, will be web-based and will link to the installations' CTP2 Management Action Plans (MAPs).

The Pollution Prevention Opportunity Assessment (P2 OA) was refocused to address groups of compliance sites instead of waste streams or specific chemicals. The highest priority compliance site groupings will now be evaluated in process specific P2 OAs, which will use a focused approach to identify root causes and examine a process in greater detail than does the traditional base-wide P2 OA. The end result will be a "short list" of potential P2 solutions. The return on investment (ROI) for these solutions can be evaluated and a preferred solution selected. Plans for implementing the P2 solution will require buy-in from the ESOH community, process owner, and weapon system manager, and the MAP will document programming in the base budget as needed. The CSI will then be updated with the projected cost and risk reduction for these sites.

CTP2 Field Test Objectives

The objectives of the CTP2 field test include: 1) validating the content and functionality of the entire CTP2 process (as shown in Figure 7), and 2) validating the process specific P2 OA protocol.

During the Robins AFB field test, AFMC/CEVV will conduct the following activities:

- Validating the CTP2 MAP process structure and documentation
- Evaluating the functionality of the CSI Oracle Database, and the compliance site designation and burdens.
- Grouping and prioritizing compliance sites and selecting groups for process specific P2 OA testing.

These tasks will support the testing of the process specific P2 OA protocol, which will be conducted in May 2000. The process specific P2 OA will be conducted for at least two groups ranging from simple to complex. Results from this effort will be shared at the next AFMC Center Working Group Meeting (CWG) at Ogden AFB in July 2000.

For further information regarding this effort please contact Steve Coyle or Bob Colson, AFMC/CEVV at DSN 787-7414.◆

ENVIRONMENTAL TECHNOLOGY IMPROVEMENT PROGRAMS AT SPACE AND MISSILE CENTER (SMC)

At Los Angeles Air Force Base, California, the Launch Programs SPO – (SMC/CL, Bioenvironmental Engineering Department (SMC/AXZB), and Aerospace Corporation are collaborating to develop, test, procure, and support deployment of a variety of research and technology solutions. The Environmental Technology Improvement Programs management approach supports research & development (R&D) solutions which are effective while minimizing costs to mitigate environmental impacts on space launch operations. Funding for this program comes from several sources such as System Program Office (SPO) funding, Small Business Innovation Research (SBIR), Aerospace R&D funds, and Strategic Environmental Research and Development Program (SERDP).

Los Angeles AFB is working on R&D solutions such as oxidizer scrubber, fuel scrubber, hydrazine spill management, hydrazine fuel vapor detection and lead-free solder.

The goal of the fuel and oxidizer scrubber project is to develop a system for treatment of toxic vapors from hydrazine fuels and nitrogen tetraoxide (N2O4) oxidizer that does not produce a hazardous waste stream. As a solution, emissions are subjected to microwave treatment during passage through carbon and catalyst beds. Highly efficient processing has been demonstrated with unsymmetrical dimethyl hydrazine (UDMH) and NO2. Follow on work will scale up to site application.

The goal of the hydrazine fuel spill management project is to develop a material to absorb and neutralize spills of hydrazine (HZ), monomethyl hydrazine (MMH), and UDMH. The fuel is absorbed into a granulated material where it is decomposed by an enzyme. Enzyme encapsulation in the absorbent granules as well as fuel decomposition by biological action has been demonstrated on a lab scale. Additional funding is required for field demonstration.

In developing an affordable soldering process that eliminates the use of lead solder in electronics, copper flakes, coated with a conductive surface, are suspended in an epoxy matrix. The Phase 2 SBIR is refining the conductive surface treatment of copper filler.

Identification of a replacement solvent for cleaning and testing LOX and N2O4 systems has led to laboratory testing of replacement candidates followed by pilot-scale cleaning demonstrations. The Aerospace Corporation has done preliminary work with SPO funding, but follow-on efforts to qualify a custom-designed solvent is currently unfunded.

Improved sensors for monitoring new exposure limit standards for hydrazine fuels have been developed and tested in the form of a personal dosimeter and a portable detector. The design goals of the pre-production units were verified by laboratory tests. Field testing has been initiated at KSC, CCAFS, and Shaw and Hill AFBs.

The goal of the Fiber Optic Hydrazine Detection and Reporting System (FOHDARS) is to develop an area monitor system for early detection of hydrazine fuel vapor from leaks. The fiber optic system utilizes a laser to monitor chemical sensors at multiple sites. Currently work is being performed to improve the reversibility of the chemical sensors and upgrading a breadboard system for field tests. Additional funding is required.

The Environmental Technology Improvement Program's immediate focus is mission success and environmental compliance on the remaining legacy flights of Titan, Atlas, and Delta as well as for future launch vehicles and satellites. For more information, please contact personnel listed in Figure 8.

Source: 14th AFMC Center Working Group Meeting, Kennedy Space Center◆

SMC Points of Contact

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Technical

Mr. Noble F. Dowling
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PO Box 92957
Los Angeles CA 90009
(310) 336-6694

Launch Programs

Lt Rodney Hargrove
Launch Programs System Program Office (CLTE)
310-363-1634

Figure 8. SMC Points of Contact

CLEAN AIR RULES THAT MAY AFFECT AEROSPACE ACTIVITIES

The last AIA article in The MONITOR discussed the Environmental Protection Agency's (EPA's) Miscellaneous Metal Parts & Products (MMPP) Rule. This article describes three other clean air rules under development by the EPA that will affect certain aspects of aerospace manufacturing and testing.

Recent budget cutbacks have created uncertainty at EPA's Office of Air Quality Planning & Standards. Nevertheless, the Clean Air Act requires that EPA continue their work on three rules that may impact aerospace activities: 1) the Rocket Engine Test Firing National Emissions Standard for Hazardous Air Pollutants (NESHAP), 2) the Engine Testing NESHAP, and 3) the Miscellaneous Organics NESHAP (The MON). The NESHAPs for Rocket Engine Test Firing and for Engine Testing are both scheduled to be proposed by February 2001. The Miscellaneous Organics NESHAP proposal, which covers the manufacture of rocket propellants and explosives as well as some other chemical products, is expected this summer.

Because of the difficulty in determining what constitutes testing versus research & development (R&D) activities in the testing of rockets or engines, EPA has decreed that both R&D as well as testing will be included in the Rocket Engine Test Firing NESHAP and the Engine Testing NESHAP. The actual launching of rockets will *not* be included in the rocket engine test firing rule and the testing of installed engines, for example - on the wings of aircraft, will *not* be included in the engine testing rule. Testing either in enclosed test cells or on test stands is included in both the rocket engine test firing and the engine testing rules.

Of special concern to the makers of explosives and rocket propellants is the anticipated requirement in The MON for 98% control efficiency of batch processes generating over 10,000 pounds of hazardous air pollutants per year. Since most control devices either burn emissions or capture emissions on carbon beds, these devices may raise the risk of detonation. It is unknown what controls are available that could meet The MON's control requirement without causing facility safety concerns. Therefore, the Occupational Safety & Health Administration (OSHA) will review the proposed EPA rule.

If the rules are *not* proposed by EPA within 18 months of their Clean Air Act due date, major sources addressed under the rules (defined as sources that emit 10 tons/year of any hazardous air pollutant or 25 tons/year of any combination of hazardous air pollutants) must apply to their states to be regulated through their Title V operating permit. This eventuality could lead to uneven regulations from state to state, complicating compliance and raising costs for organizations with facilities in several states.

AIA has developed three task groups to monitor the three rules mentioned above and to provide input, as appropriate. Information is shared among the various stakeholders, including aerospace manufacturers, DoD, NASA, commercial airlines, and other affected parties. The stakeholders agree that it is in our mutual best interest to cooperate with EPA to strive to ensure that the rules are proposed on time in order to reduce regulatory uncertainty and to insure an orderly regulatory process that allows adequate technical input from stakeholders.

For further information, contact Glynn Rountree, Director of ES&H, Aerospace Industries Association at, (202) 371-8401, glynn@aia-aerospace.org.

This article was submitted by Glynn Rountree, AIA.◆

PROGRAM MANAGER FOR THE MONITOR TRANSITIONS

Mr. Frank Brown will serve as the MONITOR Program Manager, starting with the Summer 2000 issue. Frank is a Project Engineer at ASC/ENVV and is also the Program Manager for ASC's Solutions Database (see related article on page 17). Mr. Cliff Turner has served as the MONITOR Program Manager for the last two years and is now taking a position in ASC/ENVS. The Weapon System Community wishes Cliff much success in his future endeavors and welcomes Frank as the new MONITOR Program Manager.◆

REDUCING TOTAL OWNERSHIP COSTS IN THE T-38 CORROSION CONTROL FACILITIES THROUGH ESOH IMPROVEMENTS

Air Force Policy Directive (AFPD) 90-8 recently established reduction in the environment, safety and occupational health (ESOH) component of installation and weapon system total ownership costs as a fundamental principle of the AF ESOH program. To demonstrate the positive impacts associated integrating ESOH considerations into process improvement activities, a pilot project was recently conducted at Randolph AFB, focusing on T-38 corrosion control activities. The study was conducted by the Air Force Institute for Environment, Safety, and Occupational Health Risk Analysis (AFIERA), in partnership with the HQ AETC Logistics Environmental Management Office, the Air Force Manpower and Innovation Agency (AFMIA) and the 12th Fighter Wing. The specific goals of the project were to gain insight into ESOH costs associated with the T-38 six-year strip and paint cycle, and to identify technology and work practice alternatives to improve productivity and reduce costs associated with these processes. At the outset of this project, AFMIA performed an activity-based cost (ABC) study using FY98 cost data that revealed that 22% of the costs associated with the T-38 strip and paint cycle are driven by ESOH policies and requirements.

T-38 Stripping Process

T-38 Painting Process

Design and Methods

A multidisciplinary team of ESOH professionals from AFIERA and HQ AETC reviewed current work practices and past improvement efforts, and met with process owners and shop workers to brainstorm potential improvements in personal protective equipment use, hazardous waste disposal, noise control, and ergonomics. After developing an initial list of 31 ideas, 15 were targeted for further examination. Costs and benefits were quantified for each alternative. After further discussions with the shop, five ideas were determined to have outstanding potential for reducing costs; eight had possible cost benefits; and two were discarded due to high initial capital investment costs and/or a prohibitively long pay-back period. Proposals with immediate cost reduction benefits include the following:

- Improving noise control near air compressors in the blast facility. The current sound suppression barriers inhibit heat dissipation from the compressors. In the summer, the compressors frequently overheat and shut down, resulting in down time for the shop.
- Using an off-base laundry facility to wash methyl-ethyl ketone contaminated rags instead of disposing these rags as an F005 hazardous waste;
- Recycling paint solvents through on-site distillation, instead of disposing of used solvents as hazardous waste;
- Providing operators with support stands to reduce fatigue during aircraft blasting and painting operations ;
- Substituting high-speed stripping nozzles for conventional bead blast nozzles.

Other proposals with significant cost reduction benefits, although requiring somewhat greater up-front investments include the following:

- Substituting powered air-purifying respirators for the supplied air respirators currently used in the paint shop was also recommended. Recent changes in AF policy eliminate the automatic requirement for supplied-air respirators during isocyanate spray-painting operations. The new policy requires Bioenvironmental Engineering to acquire the air sampling data needed to establish assigned protection factors and cartridge change-out schedules for shops desiring to use powered air-purifying respirators. Advantages associated with powered air-purifying respirators include elimination of fit testing requirements, increased freedom and comfort for workers, and reduced maintenance and training requirements.
- Performing additional maintenance to enhance ventilation and performance of the bead collection system in the Plastic Media Blast shop. Currently, operators must pause work periodically to facilitate media collection (via shovel or blowing the media down through the grated floor).

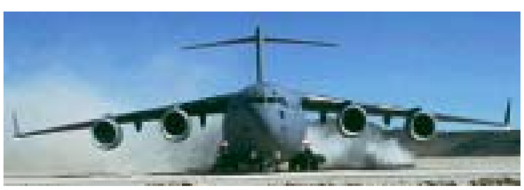
Results

Thus far, the base has successfully eliminated overheating problems associated with air compressor noise suppression and has instituted a shop towel rental agreement. Air sampling required to make the change from supplied air to powered air purifying respirators has also been completed. These changes alone will reduce the cost to paint/depaint a T-38 by approximately $1,800, or 7%. In addition, most of these improvements are applicable to other aircraft stripped/painted in these facilities (i.e, T-37, F-16), further increasing the total savings to the shop. The study clearly demonstrates the contribution ESOH professionals, working with shop workers and process owners, can make to cost and performance enhancement efforts. Tying technical solutions to performance and cost improvements is critical to accomplishing meaningful and long-term changes is AF business practices. Since completion of this study, a similar study of corrosion control activities for off-aircraft parts has been initiated at Robins AFB. A long-term goal of these efforts is to ensure that ESOH issues are appropriately considered in capital investment decisions.

For further information regarding this effort, please contact Maj Katharyn A. Grant, AFIERA at DSN 240-6116 or (210) 536-6116.

This article was submitted by Major Grant, AFIERA.◆

OVERVIEW OF THE C-17 POLLUTION PREVENTION PROGRAM



The C-17 program is one of the Air Force largest Weapon System acquisition programs. To date, 58 airplanes have been delivered to the Air Mobility Command. A program as big as the C-17 had the potential to affect the direction of the Air Force environmental program and as a result demanded a comprehensive Pollution Prevention (P2) approach and strategy. From inception, the program was committed to the implementation and execution of an exemplary P2 program. To minimize Environmental, Safety, and Health (ESH) life cycle impacts, P2 integration into the systems engineering process was of paramount importance and began very early in the C-17's development.

The vehicle for effective P2 integration was the Pollution Prevention Integrated Product Team (P2-IPT) or Environmental Working Group (EWG). The driving force behind the integration effort was the System Program Office (SPO) in a strong partnership with the Boeing Company. The SPO had a very strong customer focus and the System Program Director (SPD) was a strong supporter of the EWG. The SPO and Boeing made a concerted effort to include P2 early in system development, and to ensure P2 was integrated throughout the production, operation, maintenance and disposal of the C-17 weapon system.

Early in the production phase, the C-17 program established the P2-IPT which included representatives from both the SPO and Boeing. SPO membership included representatives from systems engineering, environmental engineering, safety, manufacturing, logistics, contracting, data management, finance, and logistics. Boeing provided representation from P2 engineering, materials and process, support systems, technical publications, safety and health, contracts, airframe engineering, reliability, maintainability and analysis, system safety, and life cycle cost estimating.

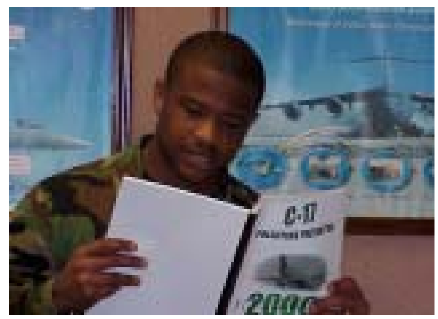
The P2-IPT is responsible for the overall direction and cohesion of the P2 program. It serves as a forum for managing ESH risk throughout the life cycle of the C-17 Weapon System. The P2-IPT assisted and advised the C-17 SPD in ESH decision making and helped C-17 contractors develop and execute a successful ESH program. The P2-IPT established P2 program objectives and tracked progress towards those objectives, review engineering change proposals and contract change proposals for ESH impacts, identified opportunities for source reduction and elimination, and implemented the best material and process alternatives. A key focus of the group is to assist C-17 installation and help bases maintain compliance with federal, state, and local environmental regulations.

The C-17 P2-IPT efforts resulted in several accomplishment for the program. The program developed and implemented advanced performance topcoat paint. The topcoat enhanced cleanability and weatherabilty performance. A reduced repaint cycle is expected with potential life cycle cost savings of $117 million. By the end of CY99, the program had seen a 79% reduction of EPA –17 industrial toxin usage in production. The P2-IPT continues to recommend projects for hazardous material reduction and elimination. Some of projects worked by the SPO include:

- Improved cleaners for exterior matte top coat
- A replacement for Methyl Ethyl Ketone wipe solvent applications
- Environmentally compliant erosion protection system for C-17 leading edge
- Evaluations of tape-type sealant
- Evaluation of impacts associated with overcoat repainting
- Environmentally compliant part sequencing (for chrome-nonchrome applications)
- Alternatives to hard chrome plating
- Implementation of cleaning compounds for parts washers
- Evaluation and implementation of a thermal electric refrigerator.

One of the tools used to manage the C-17 effort is the Pollution Prevention Cross-reference System. The system connects technical orders, logistics support analysis data, material and process specification information, and SPO generated issues via a database, which permits rapid searching for hazardous materials. The P2-IPT has also launched a web site to provide information on C-17 projects, which will promote crossfeed and avoid duplication of effort.

For additional information, please contact Major Martin Alexis, ASC/YC (AV/AVI) at DSN 986-9311.◆



Maj Martin Alexis
C-17 ESH Program Manager

C-17 PROJECTS: ELIMINATION OF CADMIUM FROM AIRCRAFT PARTS

The C-17 Program used cadmium electroplating process on various C-17 parts (e.g., landing gear). Cadmium, a toxic heavy metal and a carcinogen, is on the Environmental Protection Agency's list of 17 hazardous materials, which is targeted for reduction or removal from the workplace. The cadmium electroplating process also has health hazards associated with cyanide products in the plating bath. On 14 September 1992, the Occupational Safety and Health Administration promulgated regulations (29CFR 1910.1027) which reduced the Permissible Exposure Limit (PEL) for cadmium. The regulation greatly increased the compliance costs associated with recordkeeping exposure monitoring, medical surveillance and protective equipment for workers exposed to levels of cadmium above the PEL.

Dry film lubricants, which are traditionally applied over cadmium-plated nuts to improve lubricity, contain lead, methyl ethyl ketone, methyl isobutyl ketone, toluene, and xylene. These materials are regulated as hazardous air pollutants and toxic release inventory chemicals and are targeted for reduction as EPA-17 industrial toxins.

Since 1995, the C-17 Program has conducted four projects that target the replacement of cadmium on various C-17 aircraft parts. Additional details related to these projects are provided below.

Drop-In Replacement of IVD (Ion Vapor Deposited) Aluminum

The C-17 Program evaluated the applicability of Ion Vapor Deposited (IVD) aluminum coating as a general "drop-in" replacement for cadmium plating on the original equipment manufacturer (OEM) controlled, non-standard C-17 parts. IVD aluminum is environmentally clean and does not require pollution prevention equipment or personal protective equipment. Aluminum is safe to handle, store, and to dispose of within standard shop practices.

Based on the results of laboratory and in-service testing, 86% of these parts were determined to be easily converted to IVD aluminum. In addition, it was determined that 96% of Boeing controlled standard parts could be converted to IVD aluminum.

Under this project, the OEM identified those parts for which IVD aluminum did not serve as drop-in replacement (i.e., deep internal surfaces and oversize parts). The two projects implemented to address cadmium replacement on these parts are discussed below.

Evaluation of IVD (Ion Vapor Deposited) and Non-IVD Aluminum Replacement for Cadmium Plating

The C-17 Program implemented two projects to: 1) investigate methods to improve the applicability and functionality of IVD aluminum; and 2) evaluate non-IVD aluminum finishes for existing C-17 cadmium plating applications that involved oversized parts, parts with plated internal surfaces, and standard parts.

Extensive laboratory test and evaluation showed IVD aluminum, plus supplemental processing is functionally similar to cadmium for internal surface applications. The supplemental process evaluated zinc-nickel (alkaline) plating for internal surfaces. Based on the risk assessment and positive life cycle costs, a recommendation was made that parts with internal surface requirements be converted to IVD aluminum, plus supplemental processing and/or zinc-nickel (alkaline) upon completion of a related program. In addition, laboratory results showed the functional acceptability of a non-chromated conversion coating to replace the chromated conversion coating used with IVD aluminum.

Elimination of Cadmium on Fasteners

The C-17 Program implemented a fourth project to replace cadmium on fasteners. The purpose of this project was to evaluate the applicability of compliant IVD aluminum coating as a replacement for cadmium plating applied to threaded portions of fasteners for non-critical applications on the C-17 aircraft. Supplemental lubricants were selected to overcome the higher coefficient of friction and lower lubricity of IVD aluminum coating compounds compared to cadmium plating. This would allow installing IVD aluminum coated fasteners without revising procedures or torque tension values already established for cadmium plated fasteners.

Boeing submitted a risk analysis report to the Air Force that summarized laboratory-testing results. Some inconsistencies were observed in the torque versus tension results due to uneven IVD aluminum coating distribution on the fasteners. Based on the results of this project, Boeing could not recommend the implementation of IVD aluminum coating on threaded fasteners.

The C-17 program is a proven leader in reducing and eliminating the requirements for hazardous materials in the production, test, operation, and support of the weapon system. The program continues to search for opportunities to reduces or minimize ESH impact throughout the weapon system life cycle.

For further information regarding the C-17 Program's efforts to eliminate cadmium from aircraft parts, please contact Major Martin Alexis, C-17 ESH Program Manager, at DSN 986-9311.◆

AERONAUTICAL SYSTEMS CENTER (ASC) TRACKS POLLUTION PREVENTION PROJECTS IN THE SOLUTIONS DATABASE

Figure 9 provides an overview of the Hazardous Materials Reduction process at Aeronautical Systems Center (ASC). The process begins by documenting a baseline of hazards contained in weapon systems such as Ozone Depleting Substances (ODSs), EPA-17 chemicals, hazardous air pollutants, and other concerns. The baseline is then used to conduct cost and trade studies on the identified hazards and to identify potential commercial solutions. If necessary, the technical orders and military specifications may be modified. After performing the cost and trade studies, ASC then evaluates alternative products. To date, the hazard reduction process lacks a way to follow-up on pollution P2 after implementation.

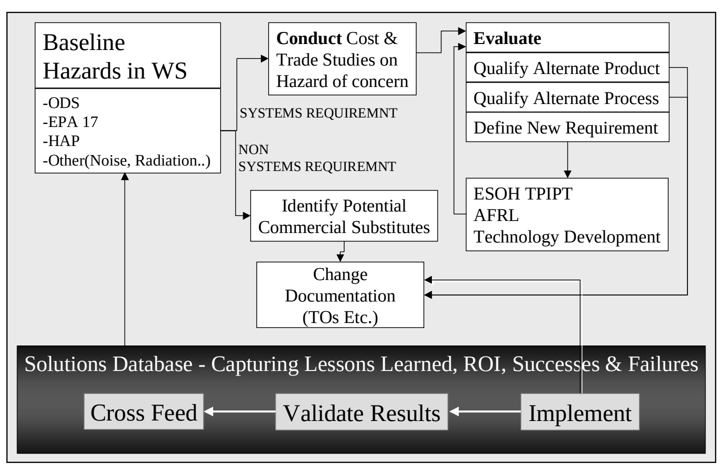


Figure 9. Hazardous Materials Reduction Process at ASC

From 1994 to the present, the System Program Offices (SPOs) and other organizations affiliated with ASC/ENVV have performed a large number of P2 projects that impact some phase of the Air Force weapon system life cycle. Since the majority of the Air Force weapon systems are managed at ASC, validation and tracking of historical and on-going P2 projects at the SPO, will provide useful analytical results, technical solutions, and success stories that can be leveraged to benefit the Air Force and Department of Defense (DoD) community.

Project Description

With sponsorship from HQ Air Force Materiel Command (AFMC) Pollution Prevention Integrated Product Team (P2IPT), ASC is developing a Knowledge Management Tool that captures historical P2 projects implemented by the SPOs and will serve as a tool to direct future investment decisions.

ASC/ENVV is currently fielding the Solutions Database. The future role of the Solutions Database in supporting ASC/ENVV's P2 investment decision-making process is summarized in Figure 10. Weapon systems designers or ASC/ENVV home office personnel can use the database to determine if a requirement has already been identified and/or resolved. If the requirement has not been resolved, ASC/ENVV will prioritize it within the investment Roadmap and search for potential sources of funding. After the project has been funded and implemented, both the Solutions database and the Roadmap will be updated to reflect the results.

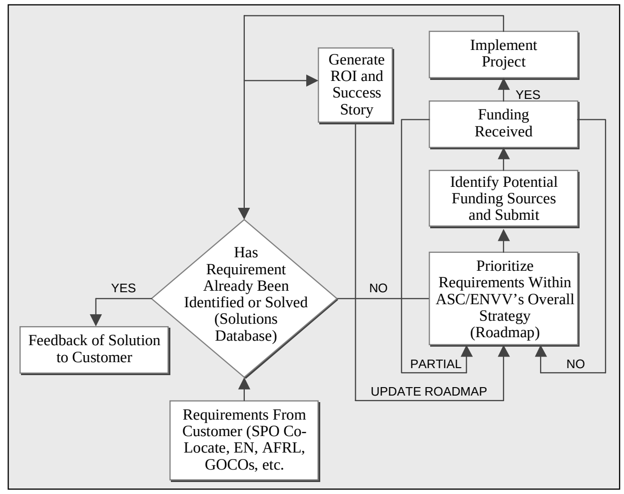


Figure 10. ASC's Investment Strategy

Results

To date, over 200 projects have been identified for inclusion in the Solutions Database. These projects includes ASC SPO, Air Force Research Laboratory (AFRL), Government Owned Contractor Owned (GOCO) and contractors efforts between 1994 – 1999. Seventeen (17) data elements will be collected for each of these projects and made available to ASC through an Access Database that is ported to the Web.

Approximately 60 Needs currently maintained by the Environmental Safety & Occupational Health Technology Planning Integrated Product Team (ESOH TPIPT), indicating an AF requirement, have been tied to projects in the Solutions Database. Some projects represent a one-to one solution for a need. Others projects are aggregated as examples of work being done that could be leveraged when solving similar needs. The linking of Solutions to Needs between the Solutions Database and the ESOH TPIPT Needs clearly demonstrates that the Air Force is working on solving problems, which often are not being captured in a systematic manner.

This issue of the MONITOR cross-feeds information on some of the projects listed in the Solutions Database. For more information about the Solutions Database, please contact Mr. Frank Brown, ASC/ENVV at DSN 785-3059 ext. 310.◆

ASC/ENVV IMPLEMENTS AN ENVIRONMENTALLY COMPLIANT PARTS PROCESSING SEQUENCE (ECPPS) PROJECT

The current process used to protect steel alloy parts from corrosion is a three-part process. This process involves an electroplated cadmium coating followed by a spray-applied primer containing chromium, and finally, a spray-applied paint topcoat. This process has its drawbacks since it is a major generator of Hazardous Air Pollutants (HAPs) and Volatile Organic Compounds (VOCs). In addition, cadmium and chromium are both on the EPA-17 list of hazardous materials (HazMats) targeted for elimination, and are probable or known carcinogens. Cadmium and chromium cause even more environmental problems in the maintenance community. A plane's structure is stripped of paint periodically for both weight reduction and inspection. High strength alloy steel parts, such as those in landing gears, are also periodically removed from the aircraft and stripped of paint and cadmium for inspection and repairs. Afterward, the parts undergo a finishing process similar to that used during the original manufacture.

Stripping operations often involve mechanical abrasive procedures that create cadmium and chromium dust. Protecting workers from this dust leads to stringent and costly process controls, increased medical surveillance and multi-year record keeping. Additionally, the material used in the stripping process is labeled hazardous waste once it becomes contaminated with cadmium and chromium. For example, the largest single hazardous waste stream generated at Ogden Air Logistics Center (OO-ALC) is the abrasive blast waste. This waste stream amounts to about 350,000 pounds per year.

Project Description

Aeronautical Systems Center, Pollution Prevention Branch (ASC/ENVV) which owns the Applied Technology Program, developed an Environmentally Compliant Part Processing Sequence (ECPPS) to mitigate the above situation. The ECPPS involves a process used to protect alloy steel parts from corrosion involving an electroplated cadmium finish, a spray-applied primer containing a chromated corrosion inhibitor, and a spray-applied paint topcoat. What makes the ECPPS unique is its application to the internal surfaces of parts. Other initiatives reduce the use of cadmium and chromium-containing primers and paints, but are generally limited to external surfaces. These do not address the unique problems of internal parts and surfaces where cadmium is presently used extensively.

The purpose of this project, which was funded by HQ AFMC P2IPT, is to develop and implement a technology transfer plan for the ECPPS, which entails coordinating an Air Logistics Center (ALC) demonstration site, equipment acquisition, installation, demonstration, validation, and training. The ECPPS project was presented to the OO-ALC as a partnering opportunity to participate in identifying alternatives to hazardous materials for landing gear details.

Results

The work performed under the ECPPS project proved that Ion Vapor Deposited (IVD) Aluminum and Sputtered Aluminum processes are environmentally friendly alternatives to cadmium plating for high strength alloy steels used on landing gear parts. This "green" process will eliminate most of the cadmium and chromium waste stream at OO-ALC. A sputtered aluminum process demonstration is planned for August 2000 at the Boeing Aerospace, St. Louis. A follow-on effort to this project will install the environmentally friendly plating process at OO-ALC in October 2000.

In 1999, ASC/ENVV received an honorable mention in the White House's *Environmental Closing the Circle Award* for contributing to "Greening the Government" through its ECPPS Project.

For further information regarding this project, please contact Mr. Chuck Valley, Environmental Program Manager, ASC/ENVV, at DSN 785-3054, ext. 332.

This project is listed in ASC's Solutions Database.◆

F-16 PROGRAM: REDUCTION OF CHROMATED SEALANTS

Sealant materials are used for a variety of purposes including fuel tank sealing, corrosion prevention, and cockpit pressurization sealing. The sealant used to install fasteners in the F-16 was formulated with corrosion inhibiting chromium filler in case the external paint cracked around the fastener heads due to structural strain. In particular, the lower wing skins and inlet ducts were susceptible to paint cracking. The replacement of epoxy primer with flexible polyurethane primer for external painting has reduced that risk. However, a chromium-free corrosion inhibiting sealant for fastener installation remained desirable as an added service life factor.

In the FY 96, Environment Safety, and Occupational Health (ESOH) Technology Needs Survey (TNS), Aeronautical Systems Center (ASC) identified the need to find a replacement to chrome-containing sealant for the F-16. Replacement of the chromium containing sealant was driven by environmental regulations that require these materials to be disposed of as hazardous waste if they exceed the toxic leachate characterization profile (TCLP) test for chromium.

Project Description

Lockheed Martin Aeronautics Company (LM Aero) initiated a program to eliminate chromium filled sealants at Air Force Plant 4 in 1996. With research & development (R&D) funds provided by the F-16 System Program Office (SPO), LM Aero began testing sealants from various manufacturers. The sealant qualification testing was conducted in two phases. The sealant manufacturers conducted the conventional testing, with spot checks by LM Aero. Structural joint loading using coupons similar to MIL-S-81733 were prepared and tested by LM Aero to evaluate corrosion aspects in a realistic joint. For the joint testing, one group of coupons included aluminum alloys, fasteners, and coating representatives of the wing box. A second group was representative of the inlet duct assembly.

Results

Based on the results of the project, three sealants, i.e., PR1775, PR1875, and MC730 (now identified as AC730) were found acceptable under FMS-3055-1 and have been implemented into F-16 production. The manufacturer subsequently submitted PR1781 sealant as a cost competitive replacement for PR1875 for qualification to FMS-3055-1. Qualification testing that paralleled that of the SPO project was successfully accomplished as a second source item along with CS 5500 CI sealant. PR1781 has a minimum quantity restriction for procurement. Hence, PR1775 was also retained because it is more economical for small purchases. Sealants containing chromium were phased out of the F-16 Program at LM Aero – Fort Worth in the first quarter of 1997.

For further information regarding this project, please contact Mary Wyderski, F-16 SPO, at DSN 986-6178 or Bob Wolff, LM Aero, at (817) 777-2138.

This project is listed in ASC's Solutions Database.◆

AFRL/MLS-OLR PROJECT QUALIFIES ALTERNATIVE (NON-ODC) AVIONIC CLEANERS

Alternative non-ozone depleting chemicals (ODCs) are currently being employed to clean avionics components and associated equipment during maintenance/repair cycle(s). However, substantial variation exists among the commercially available alternatives regarding cleaning effectiveness for removal of various lubricant/corrosion prevention compounds during maintenance/repair activities. In addition, certain non-ODC substitutes exhibit aggressive attack on ancillary components of the avionics packages (e.g., elastomers and sealant degradation and corrosion of metals).

Project Description

The objective of this project, funded by the Headquarters Air Force Materiel Command Pollution Prevention Integrated Product Team (HQ AFMC P2IPT), was to develop non-ODC cleaning materials and processes to clean avionics components during maintenance and repair cycles. The project was broken down into three phases. Phase I was used to develop test methods and criteria. Phase II established benchmark baselines and began initial screening of candidate materials. Phase III completed additional testing/evaluation and provided documentation for Department of Defense (DOD) approval and publication of T.O.1-1-689.

Results

The result of this effort has produced an additional cleaning track (Track 8) to the Tri-service regulation NAVAIR 16-1-540, T.O. 1-1-689, and TM 1-1500-343-23 using environmentally compliant materials. Chem-Tech 1 and 2L cleaning solutions, manufactured by Chem-Tech International Inc., are used in Track 8 cleaning track. The Chem-Tech 1 cleaning solution is a water-based multi-purpose cleaning detergent used to clean electromechanical and electronic assemblies. CT-2L is a single step cleaning agent to supplement treating agent following CT-1 cleaning agent.

For further information regarding this project, please contact Mr. Dave Ellicks, AFRL/MLS-OLR at DSN 468-3284.

This project is listed in ASC's Solutions Database.◆

AFRL/MLS-OLR EVALUATES ENVIRONMENTALLY COMPLIANT CORROSION CONTROL PROCESSES FOR AIR FORCE GROUND-BASED VEHICLES (AFGBV)

Currently, Air Force ground-based vehicles (AFGBV), located or operated in moderate to severe corrosion prone environments, experience significant corrosion within months of delivery. If left untreated, the resulting corrosion can cause structural failure, longer downtime for maintenance, and shorten service life. Based on a review of past vehicle related surveys conducted by the Air Force, the root causes of premature corrosion occurrences of AFGBV are attributed to inadequate or improper material selection and an inadequate corrosion prevention and control process application during manufacture or repair.

Project Description

Since 1994, the Air Force Corrosion Prevention and Control Office, (Air Force Materials Laboratory Support-Operating Location Robins (AFRL/MLS –OLR)) received funds from Air Force Materiel Command Pollution Prevention Integrated Product Team (AFMC P2IPT) to identify effective, readily available, environmentally compliant corrosion prevention and control processes for AFGBV that could be integrated at both the organizational and depot levels.

The approach taken on this project was to evaluate conventional and alternate technologies that could be readily integrated at the original equipment manufacturer (OEM), depot, or military organizational maintenance levels. Various zinc-containing primers, thermoset powders, high deposition metallization, acrylic polyurethane topcoats, and 100% solids coatings were among the readily available corrosion inhibiting technologies identified. Seven (7) of the 15 promising alternate coatings were selected for field evaluations.

Results

Field evaluations, completed in 1998, recommended the following coating systems:

- Metal Wire Arc Spray (MWAS) using 85/15% zinc/aluminum wire for depot overhaul facilities where proper preparation and application can be conducted.
- Deft 44-GY-16 zinc-rich primer, 44-W-7 zinc-phosphate intermediate primer, and 36-GN-13 acrylic polyurethane topcoat system for properly prepared steel substrates.
- CeRam Kote54® and CeRam Grout® for erosion protection on properly abrasive blasted surfaces.

These coating systems are being integrated into the coating processes at the All Things are Possible (ATAP) cargo loader overhaul depot in Eastaboga, AL.

The success of this effort was leveraged for an ongoing Joint Group on Pollution Prevention (JG-PP) project that addresses hazardous air pollutants (HAPs) in Support Equipment (SE) within the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA).

For further information regarding this project, please contact Mr. Dave Ellicks, AFRL/MLS-OLR, at DSN 468-3284.

This project is listed in ASC's Solutions Database.◆

AFRL/MLS-OLR PROJECT OPTIMIZES NEW CORROSION PREVENTION & CONTROL PROCESS ON RADAR COMMUNICATIONS EQUIPMENT

The current methodology for corrosion control on radar and communications equipment requires removal and disposal of current coatings, repairs to equipment and support structures, and repainting using solvent-borne chromated/epoxy primers and polyurethane or epoxy topcoats. Current coating systems and techniques do not provide long-term protection and require continuous maintenance actions. Item specific technical orders are not available to cover corrosion control of carbon steel structures, the material from which most radar and communications towers are constructed. Additionally, increasing regulatory burdens require developing environmentally safe repair and maintenance process that provide long term corrosion protection.

New technology that is environmentally compliant and provides superior protection is commercially available. The depot and field level units have not had access to these technologies because of outdated technical publications and manuals. Failure to use environmentally compliant coatings and techniques for long term corrosion protection will eventually degrade the Air Force's capability in the radar and communications environment.

Project Description

Since 1994, the Air Force Corrosion Prevention and Control Office, (Air Force Materials Laboratory Support – Operating Location Robins (AFRL/MLS-OLR)) received funds from the Air Force Materiel Command Pollution Prevention Integrated Product Team (AFMC P2IPT) to: 1) conduct a study to locate environmentally compliant coatings and coating application equipment; and 2) research environmentally compliant substrate preparation processes.

This project focused on finding substrate preparation equipment for use on carbon steel for which the Glide Slope Towers and Launch Complex Maintenance Towers are primarily constructed. The project: 1) leveraged data collected through a previous effort that identified corrosion problems in the Communications and Radar fields; and 2) prototyped an environmentally compliant alternative to conventional solvent-borne top-coating and chromated primers. As a part of this effort, 147 agencies were contacted to identify environmentally compliant alternative coatings, and coating removal equipment.

Results

The effort to find products that provide greater corrosion protection for Glide Slope tower and the Space Command Maintenance tower and conform to environmental requirements was successful. However, finding a coating to protect the Umbilical tower proved to be more difficult. The Umbilical tower is subjected to high heat from rocket motors, chemical residue from rocket exhaust, high pressure thrust from rocket motors, and located in close proximity to a coastal environment.

For further information, please contact Mr. Dave Ellicks, AFRL/MLS-OLR at DSN 468-3284.

This project is listed in ASC's Solutions Database.◆

AFRL/MLQL IMPLEMENTS HAND HELD LASER CLEANER/COATINGS REMOVER PROJECT

The US Air Force has traditionally used hazardous chemicals to facilitate various maintenance activities during surface cleaning and coatings removal operations. In some applications, substituting environmentally acceptable cleaners has not provided optimum performance. Plastic Media Blasting (PMB) coating removal is employed on some weapon systems; however, in order to prepare the aircraft for PMB operations, extensive masking must be accomplished to prevent media intrusion and to protect sensitive areas. When the maskant is removed, the remaining painted surface is usually removed by hand sanding or by the use of chemical strippers. Sanding can generate hazardous air pollutants and can also damage aluminum aircraft skins. Chemical stripping can generate significant amounts of hazardous waste. There are also inaccessible areas of the aircraft, such as wheel wells and internal bays that are difficult to clean and/or strip.

Project Description

In 1995, the Air Force Research Laboratory, Materials Directorate, Weapon System Logistics Branch (AFRL/MLQL) funded a project to research the use of pulsed lasers to remove organic contaminants residues from aircraft oxygen system tubing. The process proved to be effective and techniques were developed to deliver short-pulse beams to surfaces through fiber cables terminating in a handheld cleaning unit. Recognizing the broad application of this potential technology, the scope of the program was expanded to include small-area, supplemental paint removal for depot and flight line operations and the preparation of aluminum surfaces for the adhesive bonding.

Results

The results of this project demonstrated that short-pulse laser beam technology is a potential alternative in Air Force maintenance operations for stripping small areas and preparing surfaces for adhesive bonding. As a part of the project, the contractor, Craig Walters & Associates, designed, assembled, and tested a prototype Nd YAG laser handheld unit. The unit employs a fiber optic delivery system and provides stripping rates of 20 to 30 cm2/min at a very low power of 7 watts. A follow on effort under the Joint Group on Pollution Prevention (JG-PP) will leverage the results of this project to provide scale up and transition of a hand held laser for operational use.

For further information regarding this project, please contact Mr. Tom Naguy AFRL/MLQL, at DSN 986-5709.

This project is listed in ASC's Solutions Database. Mr. Joe Kolek, AFRL/MLQL, prepared this project summary. ◆

PROPULSION ENVIRONMENTAL WORKING GROUP (PEWG) UPDATE

The Propulsion Environmental Working Group (PEWG) is currently engaged in the activities/initiatives summarized below.

Frank Ivancic, PEWG Chair, and **Bob Bondaruk, PEWG Management Office**, will soon travel to Germany to attend a May 2000 meeting of the North Atlantic Treaty Organization (NATO) Research and Technology Organisation Applied Vehicle Technology (ATO/AVT). PEWG will propose the formation of a NATO ATO/AVT subcommittee to: 1) study the environmental laws/regulations promulgated by the various NATO countries; 2) and determine how those laws/regulations impact the manufacture or maintenance of NATO aircraft and engines.

The **PEWG Summer 2000 meeting** will be held from 18-20 July 2000, in Indianapolis, Indiana. Rolls Royce has kindly volunteered to host the meeting. There will be an optional tour of Rolls Royce on 17 July 2000. Invitation letters will be sent out 4-6 weeks in advance of the meeting. A meeting announcement and agenda will be posted on the PEWG website (www.pewg.com) by early May 2000.

The government contract for the PEWG Management Office has changed to Anteon Corporation. Additionally, the **PEWG Management Office is now located at Wright-Patterson Air Force Base**, collocated with the Air Force Propulsion Development System Office. The new contact information for the team is as follows:

- Bob Bondaruk 937-255-0444x3183; Bob.Bondaruk@wpafb.af.mil
- Chuck Alford 937-255-1966x3309; Charles.Alford@wpafb.af.mil
- Penny Kretchmer 937-255-0359x314; Penny.Kretchmer@wpafb.af.mil
- Jim Farrar 937-255-1966x3310; James.Farrar@wpafb.af.mil

Jim Farrar, PEWG Management Office, submitted this article.◆

UPCOMING EVENTS

Date	Conference	Location	
23-27 Jun 2000	Defense System Acquisition Management	San Diego, CA	http://www.ndia.org
18-20 July 2000	PEWG Meeting	Rolls-Royce Indianapolis, IN	Bob Bondaruk Phone: (937) 255-0444 ext. 3183
25-27 Jul 2000	AFMC Center Working Group Meeting	Hill AFB Ogden, UT	Frank Berger Phone: (937) 257-3498 Lori Luburgh Phone: (937) 257-7352
1-3 Aug 2000	Navy P2 Conference	The Ritz Carlton Pentagon City, Washington, DC	http://206.5.146.100/n45
11-15 Aug 2000	18th International System Safety Conference	Radisson Plaza Hotel, Fort Worth, TX	Myron Krueger Phone: (817) 763-3306 myron.d.krueger@LMCO.com
21-24 Aug 2000	5th Annual Joint Services Pollution Prevention & Hazardous Waste Management Conference & Exhibition.	Henry B. Gonzalez Convention Center San Antonio, TX	www.p2-hwmconference.com
23-26 Oct 2000	Systems Engineering & Supportability Conference	San Diego, CA	ddewitt@ndia.org

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